Space Weather Technical Forecast

Issued on Monday, 22 August 2022 at 00:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance G1 Minor Storms Day 1 or 2 (22nd/23rd). Active fluence expected Day 1 (22nd), easing briefly, but chance of returning later.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity is Low, with five sunspot regions on the Earth-facing disc. A number of C-flares were observed, a couple of which were from AR3078 which has now rotated off the disc as a simplifying region, but still has potential to give further flares due to some visible magnetic looping on SDO imagery. AR3085 Dai/Beta, whilst relatively small, is the most developmental region, and has also been the source of some C-flaring. This has seen its penumbral extent increase, and also some increasing complexity with surrounding emergent flux resulting in further spot development. The other regions are generally small and simple. No Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by DSCOVR and ACE persisted at elevated levels, near 550 km/s, after a brief peak near 600 km/s around 21/0400 UTC, likely due to ongoing CME on fast wind influence from CH14. The density was at or below average. The total magnetic field strength (IMF) Bt, was generally weak, at 6-9nT, with the north-south component variable between -7nT and +8nT. The phi angle was predominately negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled, with an Active interval 21/1500-1800 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV), as measured by GOES-16, was at Background levels. The high energy electron flux (greater than 2 MeV) rose from initially background levels, to be high from 21/1245, and peaking 3320 pfu at 21/1755 UTC. The 24-hour integrated electron fluence was below the Active threshold but on an increasing trend. The 22/0000 UTC observation was 9.15e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be Low to Very Low, but with a slight chance of M-flares, predominately from developing sunspot AR3085.

Solar Wind / Geomagnetic Activity: Current elevated solar winds have the potential to see further enhancements due to further weak coronal hole fast wind arrivals on day 1 or 2 (22-23rd), along with a further CME glance that is possible later day 1 or possibly day 2. This CME left the Sun on the 19th, due to a long period M1.6 flare from AR3078. This is arrival low confidence however. Day 3 and beyond is then likely to see these elevated winds gradually ease with no further arrivals forecast. Geomagnetic activity is forecast to be Quiet to Unsettled, with a chance of Active intervals day 1 and 2 (22nd and 23rd), but with a chance of rising to Active to G1/Minor Storms due to any CME and coronal hole fast wind arrival. This activity easing to Mainly Quiet with Unsettled intervals possible day 3 and day 4 (24th and 25th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is forecast to remain at Background levels. The high energy electron flux (greater than 2 MeV) is likely to persist at high before a drop out back to background levels on day 1 or 2 from any coronal hole fast wind or CME arrival, although this is low confidence. A recovery of values is

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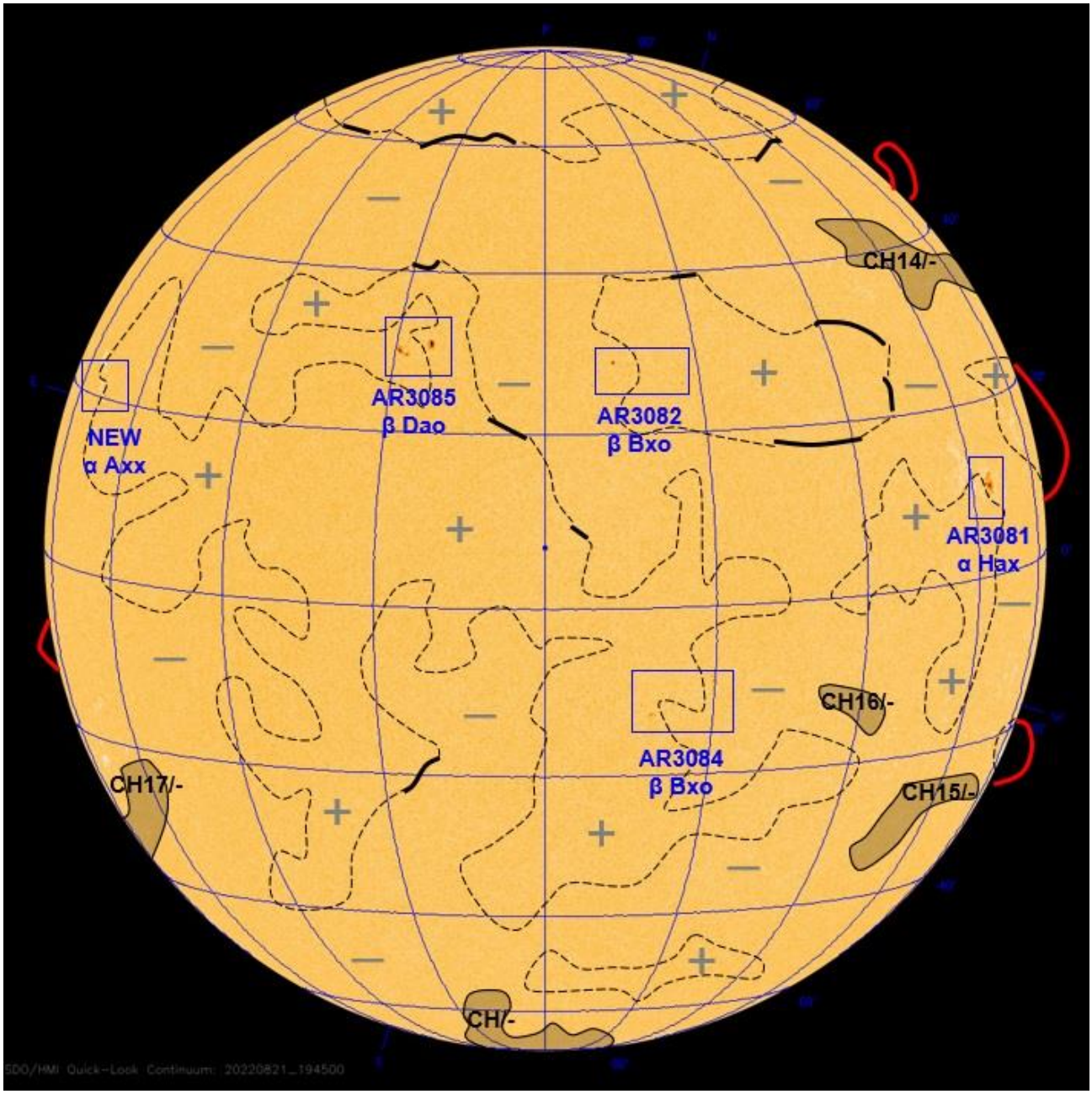
then expected day 3 onward. The associated 24 hour electron fluence is likely to become Active early day 1 (22nd), before falling below again during day 2 (23rd) due to any flux drop out. There is significance uncertainty beyond this, with fluence values likely to recover close to, or perhaps rising above the Active threshold.

Figure 1. Solar Analysis Valid 21/2000.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Solar winds at Earth have been elevated due to ongoing CME and coronal hole effects. These are expected to ease for a time early on day 1 (22nd), before a further CME is indicated to potentially give a glancing impact later in the day. This is the last of the CMEs from AR3078 that is expected to have an Earth-directed component, and left the Sun on the 19th, due to a long period M1.6 flare. Forecast arrival is 21/1800 UTC +/- 12 hours.

Further small coronal holes are present in the southwest disc, with fast wind enhancements from these also possible day 1 or day 2 (21st and 22nd), increasing the potential geomagnetic activity. This may be the cause of the weak enhancement seen on STEREO A early on the 20th, which suggests arrival early day 1 (22nd), however Enlil suggests a later arrival on day 2 (23rd). Solar winds are expected to ease day 3 (24th) onward.

Geomagnetic activity is forecast to be Quiet to Unsettled, with a chance of Active intervals day 1 and 2 (22nd and 23rd), but with a chance of rising to Active to G1/Minor Storms due to any CME and coronal hole fast wind arrival. This activity easing to Mainly Quiet with Unsettled intervals possible day 3 and day 4 (24th and 25th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	30	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
19/0922 UTC	Partial	M1.6 Flare	SW AR3078	700	22/1800 +/- 12 hours	Very low confidence. Glancing impact.

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Figure 2: Enlil and Ensemble showing potential CME arrival, and also fast win enhancement.

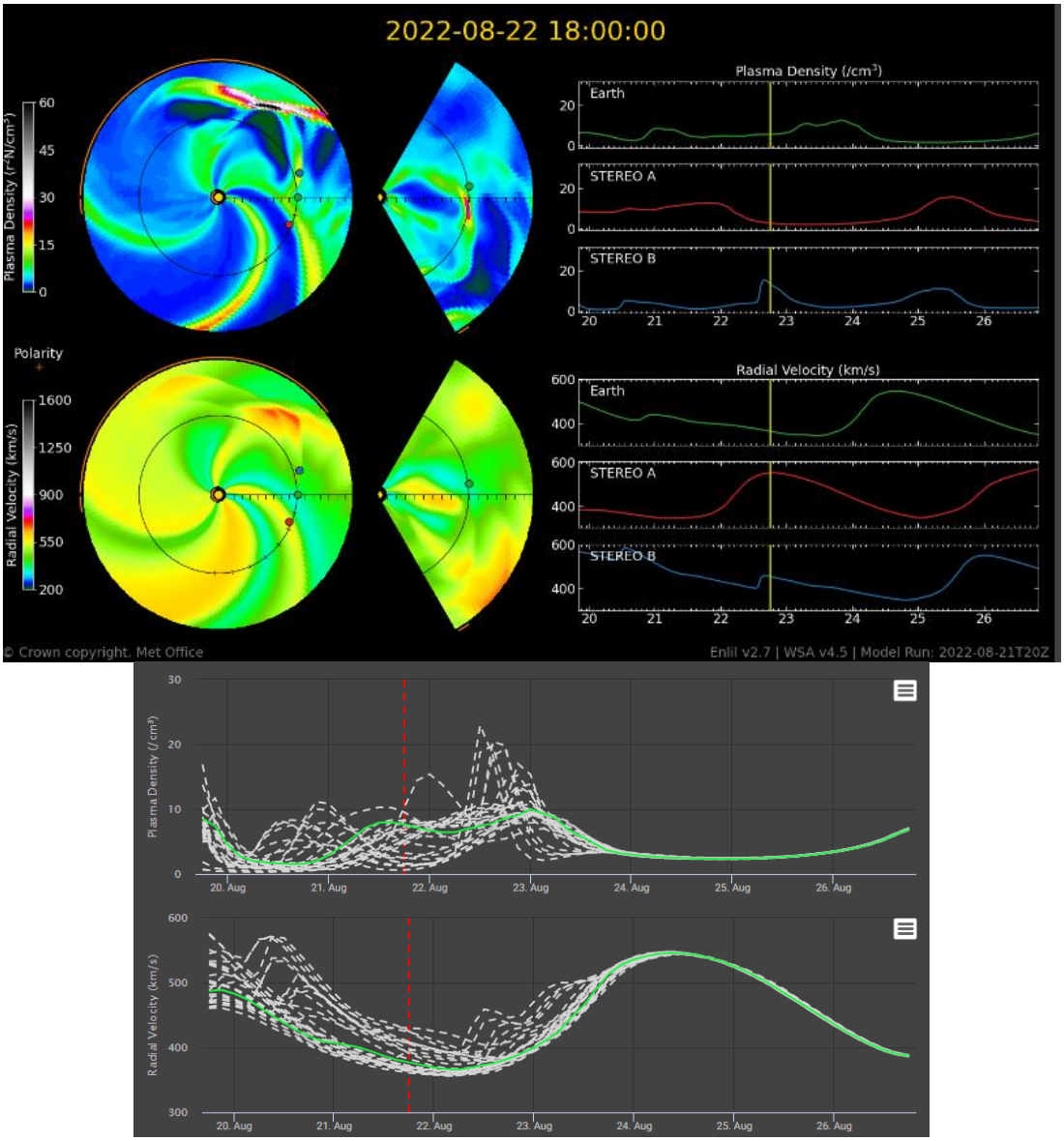
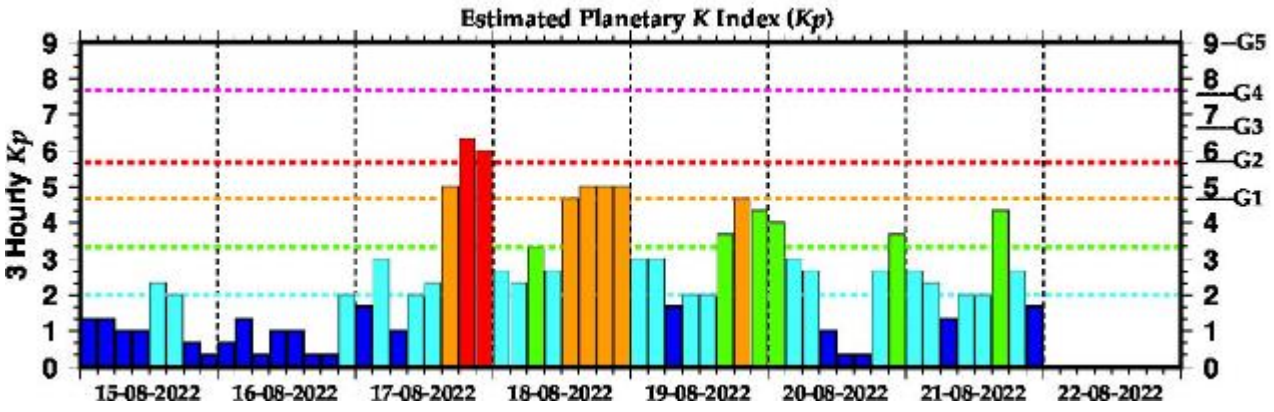


Figure 3: BGS Estimated Kp observations over last 7 days.



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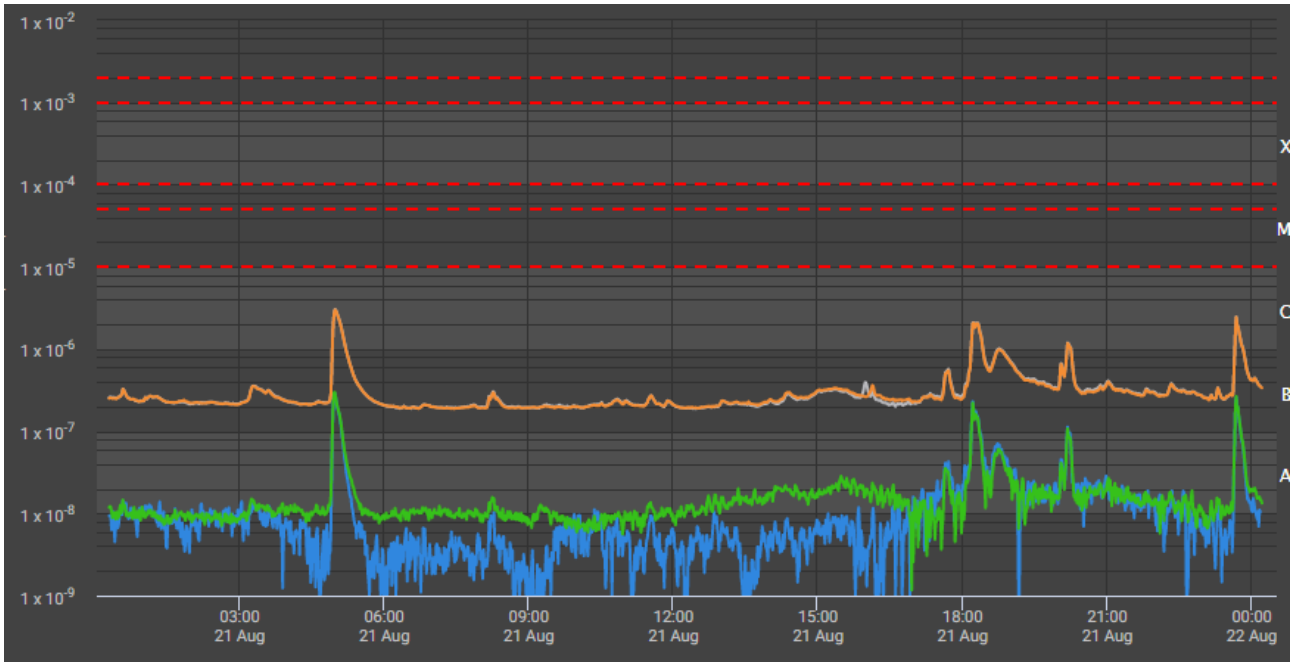
Radio Blackouts - X-Ray Flares:

Solar Activity is Low, with a few low C-flares observed in the last 24 hours. A couple of these were from ongoing activity from AR3078, which has been rotating off the southeast limb and is no longer visible, but with associated magnetic looping still evident in SDO imagery. A further couple of C-flares were also observed from newly developing region AR3085 Dai/Beta in the northeast disc, and this is likely to be one of the main sources of any further activity. This region has shown growth in both penumbra area of main leader and trailer spots, and some development of surrounding small spots, although does still remain fairly small, and a relatively magnetically simple region.

There are a total of five sunspot regions on the disc, however all other regions are small and simple. A region of newly emergent flux towards the northeast limb does need monitoring for further development, however. Activity is expected to be Low to Very Low, with a chance of further C-flares and just a slight chance of M-flares.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: GOES-16 X-ray Flux



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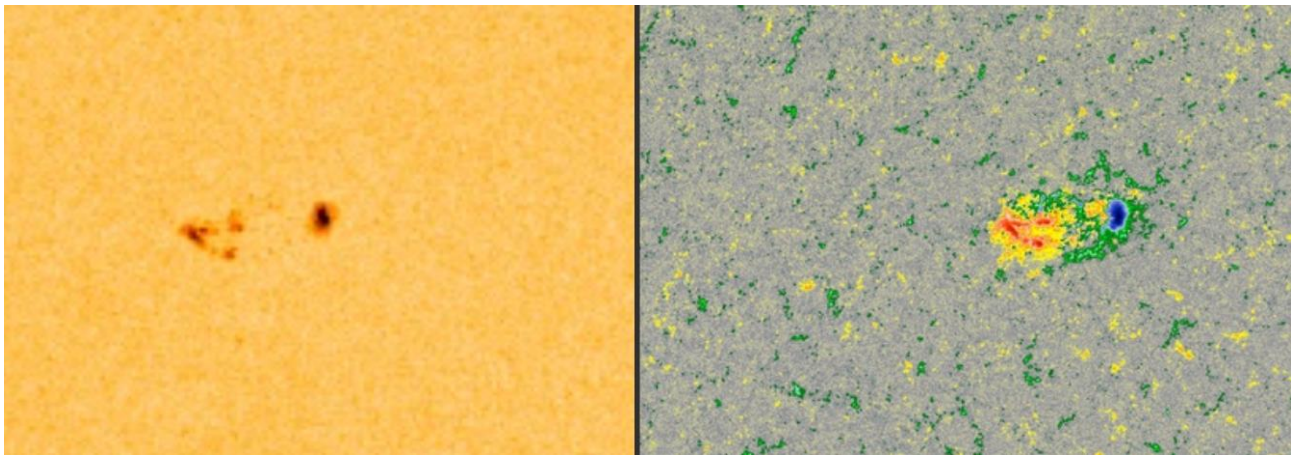
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 is at background, and is expected to remain at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: SDO Hmi-intensitygram and magnetogram of AR3085



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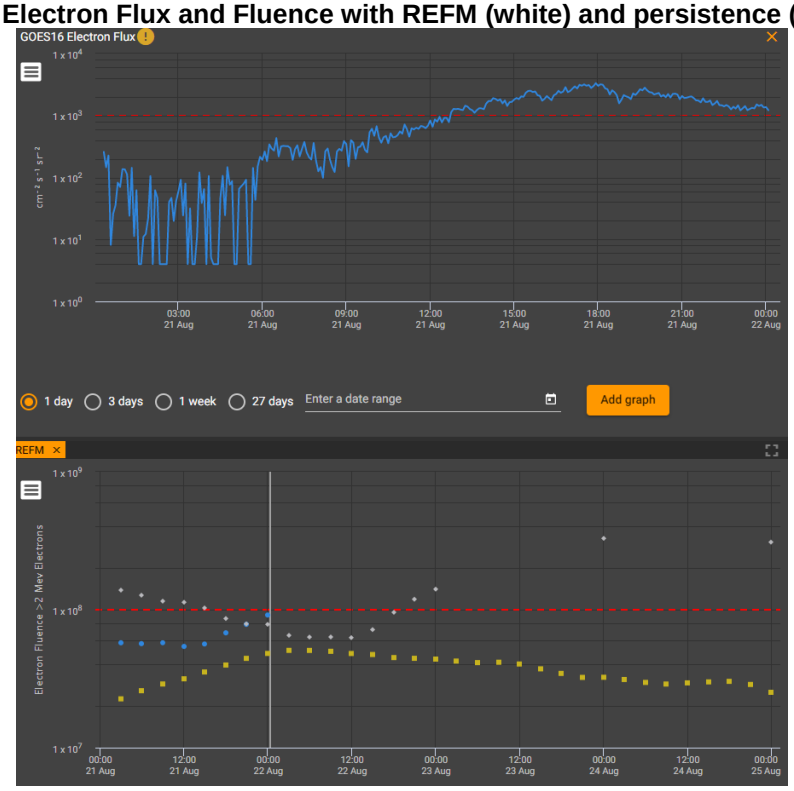
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as measured by GOES-16 is currently high after recent coronal hole and CME enhancements to the solar wind environment. This high flux is likely to drop out with any further CME, or potential coronal hole fast wind arrival on day 1 and day 2 (22nd and 23rd). The timing and strength of these is low confidence, however as the CME is only indicated to give a glancing impact, whilst the coronal holes are small and not persistent features. A recovery of flux to moderate, perhaps high is then likely later day 3 and 4 (24th and 25th). If the CME misses, and the fast wind arrival is not distinct, then it is possible high flux will persist throughout.

Due to the significant uncertainties in the flux forecast, the extent of Active fluence is Low confidence. On day 1 (23rd) fluence is likely to continue rising, above the Active threshold, before any dropout in flux later, or day 2 (24th). This will likely result in fluence falling below Active again later that day. There is then a chance of further Active fluence later in the period, depending on how flux recovers. REFM supports Active fluence throughout, however this doesn't take account of any CME or coronal hole fast wind arrival, and is likely over-estimating fluence once this occurs.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	90	70	40	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 6: GOES-16 Electron Flux and Fluence with REFM (white) and persistence (yellow)



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